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ON SPECIES OF PHOXOCEPHALUS AND APHERUSA.

By W. T. CALMAN, B.Sc., University College, Dundee.

(Plates XXXI. and XXXII.)

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XX.

ON SPECIES OF PHOXOCEPHALUS AND APHERUSA.

By W. T. CALMAN, B.Sc.,
University College, Dundee.

(Plates XXXI. and XXXII.)

[FORWARDED BY PROF. D'ARCY W. THOMPSON, COMMUNICATED BY DR. E. P. WRIGHT.]

(Read May 27, 1895.)

Of the species described in the present paper, two, *Phoxocephalus fultoni*, T. Scott, and *Apherusa borealis*, Boeck, were collected in the West of Ireland; the former near Galway, by Professor D'Arcy W. Thompson (under whose direction this paper has been prepared), and the latter at Roundstone, county of Galway, where we spent some weeks last summer, aided by a grant from the Flora and Fauna Committee of the Royal Irish Academy. In the case of the third species, *Phoxocephalus simplex*, Spence Bate, I have thought it advisable to give a detailed description and figures of this imperfectly known form for comparison with the closely allied *Ph. fultoni*, although the former species has not yet been recorded from Ireland.

Phoxocephalus fultoni, T. Scott. (Plate XXXI., figs. 1, 2.)

1890. *Ph. fultoni*, T. Scott. Additions to the Fauna of the Firth of Forth, Eighth Rep. Scot. Fishery Board for 1889, pp. 327, 328, Pl. xii., xiii.

1892. *Ph. fultoni*, D. Robertson. Second Contrib. to Cat. of Amphip. and Isop. of the Clyde. Glasgow.

1893. *Ph. chelatus*, Della Valle. F. and F. des Golfes von Neapel., vol. xx. ; Gammarini, pp. 742, 743, Pls. v., xxxv.

A single female specimen of this form was found in some tow-net material collected by Prof. D'Arcy Thompson in August, 1892, near Galway. In addition to this I have found in the Museum of University College a gathering consisting entirely of adult males of this and the following species among a collection of Amphipoda presented to the Museum some years ago by Dr. David Robertson of Cumbrae. These I have been able to compare with type specimens from the Firth of Forth, kindly sent us by Mr. T. Scott, and we are also indebted to Mr. A. O. Walker for specimens from the Menai Strait.

DESCRIPTION.—*Body* compressed, especially in the male.

Cephalon exceeding in length the next three segments; dorsal border nearly straight.

Coxal plates.—First pair (fig. 1, *gn'*) expanded distally, where they are broader than the two succeeding pairs. Distal edge rounded, with three or four bristles near the posterior corner. Two succeeding pairs (fig. 1 *gn''* and p^1), oblong-quadrangular with the anterior lower corner slightly produced and truncated. About four bristles on posterior part of distal edge. Fourth pair (fig. 1, p^2), twice as broad as the preceding, with a deep notch at the posterior upper corner. Posterior lower corner evenly rounded. Fifth pair with posterior lobe sharply rounded below.

Last pair of *epimeral plates* of metasome rather sharply rounded at the lower corner, posterior edge slightly convex.

Eyes well-developed in both sexes, larger in male. Pigment dark.

Superior antennæ.—In the *female* (fig. 1 *a'*), not quite equalling the cephalon in length. First joint of peduncle about equal in length to the other two together. Flagellum shorter than the peduncle, of four joints, terminating in a short seta. Accessory appendage two-thirds the length of the flagellum, three-jointed.

In the *male* (fig. 2 *c*), longer than the cephalon. First joint of peduncle with a dense tuft of hairs posteriorly. Flagellum longer than the peduncle, terminating in a long seta. In most of our specimens the flagellum is five-jointed, but in the specimen figured there are six joints. Five joints are recorded by Dr. Robertson, and Mr. Stebbing found the same number in two male specimens dissected by him. The first joint of the flagellum

bears a calceolus, and one sometimes occurs also on the second joint. Accessory appendage three-jointed, half the length of the flagellum.

Inferior antennæ.—In the *female* (fig. 1 *a''*), about one-third longer than the superior; penultimate joint of peduncle the largest. Flagellum very short, about equalling the last joint of the peduncle, three-jointed. Flagellum and last two joints of peduncle sparsely setose.

In the *male* (fig. 2 *c*), about as long as the body. First three joints of peduncle densely hirsute in front. Last joint with a single calceolus on front surface. Flagellum of about twenty-two joints, terminated by a slender seta. A calceolus is present on each of the first eight or nine joints, and then one on each alternate joint.

Mandibles (figs. 1 *m*, 2 *m*) with molar expansion rudimentary. Palp not very slender. In the female specimen dissected, the molar expansion is represented by a small tubercle, and the palp is naked except for a tuft of setæ at the tip. In a male specimen the molar tubercle could not be distinguished, and there were one or two setæ on the sides of the palp.

Maxillæ.—First pair (fig. 1 *mx'*) with very small palp, tipped by about three small spines. Second pair (fig. 1 *mx''*) with outer lobe larger than inner.

Maxillipeds (fig. 1 *mp*) with masticatory lobe exceeding the basal lobe, armed with a few small spines. Penultimate joint of the palp small, cylindrical, not produced at the outer corner. Dactylus about equalling the preceding joint.

Gnathopods.—The two pairs differ slightly in size and shape.

In the first pair (fig. 1 *gn'*), the inferior edge of the carpus is produced below into a rounded lobe which bears a spine. The hand is sub-quadrangular, articulated to the carpus near the anterior proximal corner, and the proximal edge is rounded. The palmar edge slopes downwards from the articulation of the dactylus, meeting the posterior edge at an acute angle, and making the hand approach to a chelate form. The palmar edge carries a row of small setæ and terminates in a tooth which is hollowed on its inner side to receive the tip of the dactylus. A strong spine springs from the inner side of the tooth (fig. 1 *gn''*, ×).

In the second pair (fig. 1 *gn''*) the carpal joint is not produced at its

lower border. The preceding joint is trapezoidal in shape, and the carpal joint is articulated to its anterior edge, while the posterior inferior corner is produced and terminates in a strong spine. In the case of the second gnathopods, therefore, the disposition of these joints approaches the condition in *Ph. simplex* described below. The hand is similar in shape to that of the first pair, but is somewhat broader.

Pereiopods.—Second last pair (fig. 1 p^4), not very slender, not more than one-third the length of the body. Basal joint oval, anterior edge very convex with a series of tufted setæ on its distal half. The posterior edge is produced into a rounded lobe which reaches to the base of the fourth joint.

Last pair of legs (fig. 1 p^5) very short in female, somewhat longer in male. Basal joint very much expanded posteriorly, edge crenated, with small bristles springing from the depressions. In the male, the front edge of the fifth joint bears three blunt curved spines similar to but weaker than those described below in *Ph. simplex.*

Uropods.—Last pair very different in the two sexes. In the female (fig. 1 up^3) they are short and stout, about equal in length to the second pair, basal joint scarcely longer than broad, the inner ramus half the length of the first joint of outer ramus. In the male (fig. 2 up^3), more elongated, much longer than preceding pair, basal joint twice as long as broad, both rami well developed and with long plumose setæ on their inner edges. Inner ramus equalling the first joint of outer ramus.

Telson deeply cleft, lobes truncated, with a spine and some small setæ on tip.

Mr. Scott's description of the species, though incomplete, leaves little doubt that his form is the same as that which I have examined, and this is confirmed by examination of the specimens kindly sent us by him. The chief discrepancies in his account are due to the fact that what he describes as the female is really the immature male, while his male is the true female.

Dr. Robertson's account deals only with the male, and so far it agrees very well with my observations.

In his monograph on the Amphipoda, Della Valle, who seems not to

have seen either Mr. Scott's or Dr. Robertson's papers, describes a new species, *Ph. chelatus*, which appears to be identical with the present form. His brief description, which deals mainly with the ambulatory legs, does not differ in any point of importance from ours. His figure of the animal (Monograph, Pl. v., fig. 10), however, is such as to raise some doubt as to the identity of the species. The difference in size between the two pairs of gnathopoda is much more marked, the hand of the second pair being nearly twice as broad as the first. The coxal plates are somewhat deeper, and the fourth differs strikingly in shape from that of the present species. It is nearly twice as long as it is broad, it has a sharp hinder corner below, and it is not notched above to receive the anterior lobe of the succeeding plate. The last pair of epimeral plates of the metasome are much more broadly rounded, and the antennæ are considerably larger relatively to the size of the animal. The figures of the appendages given on Pl. xxxv. of the Monograph agree somewhat better with ours. The flagellum of the upper antenna of the male has only four joints, but this difference is probably unimportant, for, as mentioned above, we have specimens with five and with six joints, and it is quite possible that four joints may sometimes occur. Only the two last joints of the peduncle of the lower antennæ are shown in Della Valle's figure, and there is no trace of the thick brush of hairs clothing the anterior surface of the first three joints. The figures of the gnathopods agree fairly well, though the claw, especially of the first pair, is much more curved. The basal plate of the last pair of legs is drawn with a marked angle at the lower hinder edge. No figures nor description are given of the uropods nor of the telson. With regard to the mouth-parts, the only statement is that the third joint of the palp of the maxillipeds is not spurred. In discussing the generic characters, however, Della Valle mentions (*op. c.*, p. 739) that the mandible has a small tubercle.

Of these differences the most important concerns the shape of the fourth coxal plate, and if we are to rely on Della Valle's figure, this would probably justify us in regarding the two species as distinct. In view, however, of the close agreement in most other respects, and seeing that the arrangement of the coxal plates is often very difficult to define in these

small species, it seems advisable for the present at any rate to regard *Ph. chelatus* as a synonym of *Ph. fultoni*.

Phoxocephalus simplex, Sp. Bate. (Pl. XXXII., fig. 3.)

1862. *Phoxus simplex*, Spence Bate, Cat. Amphip. Brit. Mus., pp. 97–98, Pl. xvi., fig. 1.

1863. *Phoxus simplex*, Spence Bate and Westwood, Brit. Sessile-eyed Crust., pp. 140–142.

A number of males, which I take to belong to this species, occurred in the gathering of *Ph. fultoni* above mentioned, received from Dr. D. Robertson of Cumbrae. As I have not had an opportunity of examining the female, the following description applies only to the male.

DESCRIPTION.—General shape of body and arrangement of coxal plate, closely resembling *Ph. fultoni*. First segment of urosome elevated dorsally in a rounded tubercle, which bears one or two small spines.

Superior antennæ (fig. 3 *c*).—Flagellum of four joints bearing two calceoli, and terminating in a long seta. Accessory appendage three-jointed as in *Ph. fultoni*.

Inferior antennæ (fig. 3 *c*).—Peduncle with brush of setæ on front surface, but not so well developed as in *Ph. fultoni*. Last joint of peduncle bears two calceoli on front surface. Flagellum not exceeding two-thirds the length of the body, with numerous calceoli.

The *mouth-parts* show no marked difference from those of *Ph. fultoni*, except that the mandibular palp (fig. 3 *m*) is stouter and has the second joint nearly half as long again as the third. As in that species, the tubercle of the mandible is rudimentary or obsolete.

Gnathopods.—The two pairs differ markedly in the size and shape of the manus. In the first pair (fig. 3 *gn'*) the coxal plate is expanded distally, having the anterior corner produced, and bearing three small setæ on its lower edge. The second joint is rather short and stout. The fourth joint is produced at its posterior distal corner, and tipped with a spine. The fifth joint is small, and is articulated to the front surface of the

fourth. The hand is subquadrangular as in *Ph. fultoni*, but the palmar edge slopes up from the hinge of the claw so as to meet the hinder edge at an oblique angle. The hand tapers slightly distally, and the palmar process is larger but of the same structure as in *Ph. fultoni*, consisting of a tooth notched to receive the tip of the claw and a strong spine springing within the notch.

In the second pair the coxal plate is oblong, with the distal angles rounded and three or four setæ on its lower margin. The second joint is stout and shorter than the coxal plate. The succeeding joints correspond in shape with those of the first pair. The hand is much larger than in the first pair, oval in shape, with a very oblique palmar edge, terminating about the middle of the length of the hand in a strongly-marked palmar process, which is so deeply notched as to form a kind of hood embracing the tip of the claw, and bearing a strong blunt spine (fig. 3 *gn''*, ×).

The fourth *pereiopod* (fig. 3, p^4) is very long and slender, nearly two-thirds the length of the body, and terminates in a slender claw. The basal joint is of similar shape to that in *Ph. fultoni*, and is produced below into a rounded lobe which reaches beyond the third joint. The fifth leg (fig. 3, p^5) is very short, and has the basal joint even more expanded than in *Ph. fultoni*. The fifth joint bears on the distal half of its front edge a row of three or four strong blunt curved spines (fig. 3, p^5 *sp.*).

Uropods.—Last pair (fig. 3 up^3) as in *Ph. fultoni*, but somewhat stouter; basal joint not twice as long as broad.

The identity of the above-described species with Spence Bate's *Phoxus simplex* is at once suggested by the figure of the characteristic gnathopods given in Cat. Amphip. Brit. Mus., Pl. xvi., fig. 1, *h* and *i*; though it would hardly be guessed from the figure and description in the Brit. Sess. Crust. The specimens figured in both works are young males, and many of the characters in the descriptions are merely marks of immaturity. The most obvious discrepancy is the want of eyes, and to this may be added the marked angle on the posterior edge of the basal plate of the last pereiopods. But the pigment of the eyes may have been destroyed by the action of alcohol, or, what is more likely perhaps, may be imperfectly developed in

the young animal; and the angle mentioned is very much softened down in the figure in the later book. On the other hand the above-mentioned figure of the gnathopods agrees minutely with our species. The shapes of the two hands, subquadrangular in the first, larger and oval in the second, the very oblique palmar edge and prominent palmar process of the second, and the shape and relative positions of the wrist-joints are all depicted precisely as in our species. Besides this there are some other minor points of agreement. The shortness of the last pair of legs and the great length of the second last pair are mentioned in the description; and the numbers of joints in the flagellum and in the accessory appendage of the upper antenna are correctly given as four and three respectively, though by an obvious blunder the numbers are reversed in the Catalogue. Mr. A. O. Walker, who has examined Spence Bate's type specimen of *Ph. simplex* in the British Museum, tells us, on the other hand, that he considers it to be an immature male of *Ph. Holbölli**; but, in the present state of the Spence Bate collection, it perhaps hardly follows that the single specimen therein, labelled *Ph. simplex*, truly represents the species as the author described and figured it. Indeed the discrepancy between the two descriptions given of the second gnathopods in the Museum Catalogue and the British Monograph respectively is such as to suggest that they are drawn from different species. In any case, for the reasons above given, we feel satisfied that Mr. Spence Bate did study and describe under this name an independent species, and that the same species has now fallen under our observation.

Both the species here described, *Ph. fultoni* and that identified with *Ph. simplex*, agree with the genus *Paraphoxus* of Sars (Crust. Norway, I., p. 148) in possessing well-developed eyes, in the rudimentary condition of the mandibular tubercle, and in the shape of the fourth coxal plate. On the other hand, they differ from that genus in the difference in size between the gnathopods (which is very considerable in *Ph. simplex*), in the comparatively robust palps of the mandibles and maxillipeds, and in the sparse setæ on the lower edges of the anterior coxal plates. At the

* Since the reading of this paper Mr. Walker has published the same observation in Ann. and Mag. Nat. Hist. (6), xv., p. 466 (1895).

same time, *Ph. simplex* resembles very closely in the shape of the gnathopods and in other features the *Leptophoxus falcatus* of Sars (*op. c.*, p. 147), with which, indeed, Boeck identified it (Amphip. Bor. et Arct., p. 55), erroneously, as Sars has pointed out. Sars himself, however, would place *Ph. simplex* in the genus *Leptophoxus*, since some French specimens which he refers to it "agree pretty well in all essential characteristics with the Norwegian form, though being evidently specifically distinct" (Sars, *op. c.*, p. 146). But the characters on which the genus *Leptophoxus* was founded—namely, the expanded mandibular palp, the spurred fourth joint of the palp of the maxillipeds, and the unmodified third uropods of the male—certainly do not apply to the species as described above. In short, neither of the two species here discussed can be satisfactorily placed in the system of genera adopted by Professor Sars. It is impossible to separate generically *Ph. fultoni* from *Paraphoxus oculatus*, or *Ph. simplex* from *L. falcatus*, and the only way out of the difficulty is to discard the genera *Paraphoxus* and *Leptophoxus*, and to restore the species included in them to their former places in the genus *Phoxocephalus*.

Apherusa borealis (Boeck). (Plate XXXII., fig. 4.)

1870. *Halirages borealis*, Boeck, Amphip. Bor. et Arct., p. 116.

(?) *Apherusa borealis* (Bk.), Sars, Crust. Norway, I., p. 441, Pl. clv., fig. 2 (1890–1895).

1894. *Apherusa borealis* (Bk.), Scott, Rep. Scot. Fishery Board for 1893.

A few specimens of this form were taken by the tow-net at Roundstone. The only British record hitherto is that of Mr. T. Scott, who mentions its occurrence in various places within the Forth area. As Sars mentions only a few specimens from the Lofoten Islands, and Boeck had only a solitary specimen from the Nordland coast, the species would appear to be rare. Its occurrence among so distinctly southern a fauna as we find on the west coast of Ireland is noteworthy.

The Irish specimens agree very closely with Sars' figure and description,

which, however, refer only to the female. It will be seen that Sars' lack of opportunity to study the male has introduced some inaccuracies into his description. Thus in the description of the genus *Apherusa*, Sars states that the superior antennæ are much shorter than the inferior and that the antennæ are without any trace of calceoli. I find, on the contrary, that in the male of the present species the upper antennæ are distinctly longer than the lower (fig. 4), though in the female the reverse is the case as shown in Sars' figure. Further there are numerous calceoli on the flagella of both antennæ and on the lower and inner surface of the last two joints of the peduncles (fig. 4 *a'* and *a''*). The gnathopoda (figs. 4 *gn'* and *gn''*) are somewhat stouter than those figured by Sars, and the hand is half as long again as the carpus. Sars states that the last pair of uropods have the opposed edges of the rami not serrated. I find that, in the male at least, they are very finely serrated (fig. 4 up^3), and the marginal spines are fewer than in Sars' figure. The inner ramus shows a slight outward projection at its base which is not noticed by Sars. The telson (fig. 4 *t*) bears a couple of sub-apical setæ, the presence of which has already been noticed by Scott (*l. c.*). I have figured on Pl. XXXII., the mouth parts (fig. 4 *m*, *mx'*, *mx''*, *mp*), of which Sars gives no account. They resemble very closely those of *A. bispinosa*, except that the palp of the mandible is not quite so strongly developed.

It has been suggested to me by the Rev. Mr. Stebbing that this is the "*Pherusa bicuspis*, Kröyer," of Spence Bate's, Cat. Amphip. Brit. Mus.* The synonymy of this species is in a state of considerable confusion. In the Catalogue, Spence Bate describes two closely allied species of *Pherusa*, one of which he identifies with the *Amphithoë bicuspis* of Kröyer, calling it, therefore, *Ph. bicuspis*, while the other is described as a new species under the name of *Ph. cirrus*. In the Brit. Sessile-eyed Crust. of Spence Bate and Westwood, however, the two species are united under the name *Ph. bicuspis*, the figure given being apparently copied from that of *Ph. cirrus* in the Catalogue. It has already been shown by Walker (Proc. Biol. Soc. Liverpool, II., p. 172), and by Sars (*op. cit.*, p. 350), that Spence

* Since this paper was read Mr. A. O. Walker has made the same suggestion. Ann. and Mag. Nat. Hist. (6) xv., p. 468 (1895).

Bate was in error in identifying his species with that of Kröyer, which is a perfectly distinct form belonging to another family, and is now called *Paramphithoë bicuspis*. Now Mr. Stebbing has pointed out to us that Spence Bate was again wrong in uniting the two species, his *original Ph. bicuspis* being apparently identical with the present *Apherusa borealis*, while the *Ph. cirrus* of the Catalogue, or *Ph. bicuspis* of the Brit. Sess. Crust., is also a good species, distinguished not only by the shorter antennæ with their characteristic tufts of hair, as noticed by Spence Bate, but also by the distinct rostrum and by the longer pereiopods (especially the fourth joint) as shown in the figures in the Catalogue and the Monograph. The few details given by Spence Bate render it almost impossible to make perfectly certain of the identity of his *Pherusa bicuspis* with *Apherusa borealis*, but for the present at any rate Mr. Stebbing's suggestion may be adopted. The synonymy of the two species will then stand as follows:—

Apherusa borealis (Boeck).

1862. *Pherusa bicuspis* Sp. Bate, Cat. Amphip. Brit. Mus., p. 144. (Not *Amphithoë bicuspis*, Kröyer; nor *Pherusa bicuspis*, Sp. Bate and Westwood, Brit. Sessile-eyed Crust., p. 253.)

1870. *Halirages borealis*, Boeck, Amphip. Bor. et Arct., p. 116.

(?) *Apherusa borealis* (Bk.), Sars, Crust. Norw. I., p. 441 (1890–95).

Apherusa cirrus (Spence Bate).

1862. *Pherusa cirrus*, Sp. Bate, Cat. Amphip. Brit. Mus., p. 143.

1863. *Pherusa bicuspis*, Sp. Bate and Westwood, Brit. Sessile-eyed Crust., p. 253. (Not *Pherusa bicuspis*, Sp. Bate, Cat. Amphip. Brit. Mus., p. 144.)

DESCRIPTION OF THE PLATES.

LETTERING ON FIGURES ON PLATES.

a′ a″, . .	First and second antennæ.
c, . . .	Head.
gn′ gn″, .	First and second gnathopods.
gn′, ×, .	Part of second gnathopod enlarged.
m, . .	Mandible.
mx′ mx″, .	First and second maxillae.
mp, . .	Maxillipeds.
p^1 to p^5, .	Walking legs.
p^5 *sp*, . .	Spines on fifth leg.
t, . . .	Telson.
up^1 to up^3,	Uropods.

PLATE XXXI.

1. *Phoxocephalus fultoni*, T. Scott. Female. Length, about 3·5 mm.
2. *Phoxocephalus fultoni*, T. Scott. Male. Length, about 3 mm.

PLATE XXXII.

3. *Phoxocephalus simplex*, Spence Bate. Male. Length, about 3 mm.
4. *Apherusa borealis*, Boeck. Male. Length, about 3 mm.

END OF VOLUME XXX.

W.T.C. ad. nat. del.

West, Newman sc.

PHOXOCEPHALUS FULTONI, *T. Scott.*

W.T.C. ad nat. del.

West, Newman sc.

3. PHOXOCEPHALUS SIMPLEX, *Spence Bate.* 4. APHERUSA BOREALIS, *Boeck.*